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TRAILING ARM SUSPENSION WITH ARTICULATED AXLE MOUNTING

Abstract:

A trailing arm suspension for mounting ground-engaging wheels to a vehicle frame has an axle mounted to a trailing arm through an axle-beam connector. The suspension comprises at least two arms adapted to be pivotally mounted to opposite sides of the frame and at least one wheel-carrying axle mounted to the arms through an axle-mounting assembly. Each of the axle-mounting assemblies 659
comprises a pair of beam-axle connectors which are mounted to one of the arms at one end thereof through a bushed connection and are rigidly connected to the axle at another end thereof through compression mounting or by welding. Each of the arms forms a collar which receives the axle. An elastomeric layer is positioned between the axle and the collar for articulation between the axle and the collar. Each of the beam-axle connectors is identical and is symmetrical about a longitudinal axis. Each beam-axle connector is generally triangular in two dimensional configuration and has a reinforcing gusset at an upper portion thereof and at a lower portion thereof. Each beam-axle connector further includes an arcuate plate at the other end thereof and through which the beam-axle connector is mounted to the axle. The compression mounting includes a hollow wrapper band which circumscribes the axle and is under tension sufficient to compress the axle at at least two sets of diametrically opposed and circumferentially spaced external surfaces of the axle and to prevent movement of the axle with respect to the wrapper band under ordinary service conditions.

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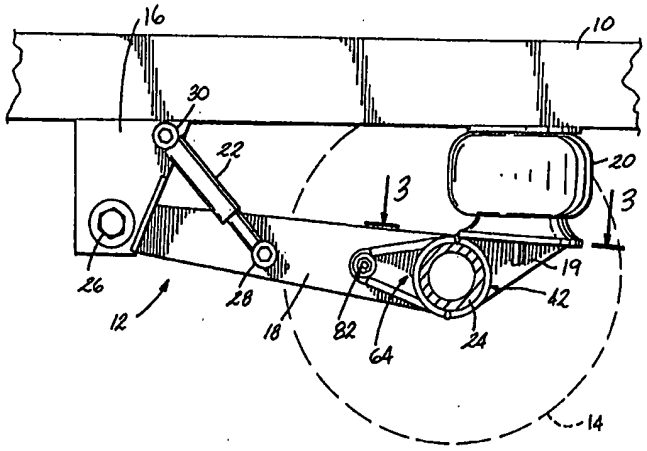

(57) Abstract

A trailing arm suspension for mounting ground-engaging wheels to a vehicle frame has an axle mounted to a trailing arm through an axle-beam connector. The suspension comprises at least two arms adapted to be pivotally mounted to opposite sides of the frame and at least one wheel-carrying axle mounted to the arms through an axle-mounting assembly. Each of the axle-mounting assemblies comprises a pair of beam-axle connectors which are mounted to one of the arms at one end thereof through a bushed connection and are rigidly connected to the axle at another end thereof through compression mounting or by welding. Each of the arms forms a collar which receives the axle. An elastomeric layer is positioned between the axle and the collar for articulation between the axle and the collar. Each of the beam-axle connectors is identical and is symmetrical about a longitudinal axis. Each beam-axle connector is generally triangular in two dimensional configuration and has a reinforcing gusset at an upper portion thereof and at a lower portion thereof. Each beam-axle connector further includes an arcuate plate at the other end thereof and through which the beam-axle connector is mounted to the axle. The compression mounting includes a hollow wrapper band which circumscribes the axle and is under tension sufficient to compress the axle at at least two sets of diametrically opposed and circumferentially spaced external surfaces of the axle and to prevent movement of the axle with respect to the wrapper band under ordinary service conditions.

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TRAILING ARM SUSPENSION WITH ARTICULATED AXLE MOUNTING

Field of the Invention

This invention relates to trailing arm suspensions for automotive vehicles. In one of its aspects, the invention relates to a trailing arm suspension wherein an axle is mounted to the trailing arm for articulation with respect to the trailing arm.

State of the Prior Art

WO 97/06022, published 20 February 1997, discloses an automotive suspension system in which an axle is mounted to an pair of axle bracket by squeezing wrapper bands around the axle to hold the axle in compression and thus retain the axle in the wrapper bands by frictional forces. The axle brackets are secured to the trailing arm through a pair of bushed joints.

Summary of the Invention

In accordance with the invention, a trailing arm suspension for mounting ground-engaging wheels to a vehicle frame has an axle mounted to a trailing arm through an axle-beam connector. The suspension comprising at least two arms adapted to be secured to opposite sides of the frame and at least one wheel-carrying axle mounted to the arms through an axle-mounting assembly. Each of the axle-mounting assemblies comprises at least one beam-axle connector which is mounted to one of the arms at one end thereof through a bushed connection and is connected to the axle at another end thereof. Each of the arms forms a collar which receives the axle. An elastomeric layer is positioned between the axle and the collar for articulation between the axle and the collar. Preferably, the beam-axle connector is rigidly mounted to the axle at the other end thereof.

In a preferred embodiment of the invention, there are two beam-axle connectors, one on each side of each arm, and each beam-axle connector is connected to the arm and to the axle in the same manner. Further, each of the beam-axle connectors is identical and is symmetrical about a longitudinal axis. Each beam-axle connector is generally triangular in two dimensional configuration and has a

reinforcing gusset at an upper portion thereof and at a lower portion thereof. Preferably, each beam-axle connector further includes an arcuate plate at the other end thereof and through which the beam-axle connector is mounted to the axle.

In one embodiment, the beam-axle connector is mounted to the axle through a hollow wrapper band which circumscribes the axle and is under tension sufficient to compress the axle at at least two sets of diametrically opposed and circumferentially spaced external surfaces of the axle and to prevent movement of the axle with respect to the wrapper band under ordinary service conditions. To this end, the arcuate plate extends about 180° around the axle and mates with a second arcuate plate to form a hollow wrapper band which circumscribes the axle and is under tension sufficient to compress the axle at at least two sets of diametrically opposed and circumferentially spaced external surfaces of the axle and to prevent movement of the axle with respect to the wrapper band under ordinary service conditions.

In another embodiment of the invention, the beam-axle connector is welded to the axle.

Description of the Drawings

The invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a side elevational view of a suspension system according to the invention attached to a vehicle frame;

FIG. 2 is a perspective view of the suspension system illustrated in FIG. 1;

FIG. 3 is a plan view taken along lines 3-3 of FIG. 2;

FIG. 4 is an enlarged cross-sectional view of the circled area labeled IV in FIG. 3;

FIG. 5 is a partial sectional view taken along lines 5-5 of FIG. 3;

FIG. 6 is a partial sectional view taken along lines 6-6 of FIG. 3;

FIG. 7 is an exploded view of the beam and axle connections of the suspension system illustrated in FIGS. 1-6;

FIG. 8 is a side elevational view, like FIG. 1, showing a modified form of the invention;

FIG. 9 is a side elevational view, like FIG. 1, showing use of the invention on a low-height suspension system;

FIG. 10 is a side elevational view of yet another embodiment of a suspension system according to the invention; and

FIG. 11 is a perspective view of the suspension illustrated in FIG. 10.

Description of the Preferred Embodiments

Referring now to the drawings and to FIG. 1 in particular, there is shown a portion of a frame 10 of a vehicle which has its forward direction to the left as viewed in FIG. 1 and a suspension system 12 according to the invention secured to the underside of the frame 10. The suspension system 12 comprises a trailing arm assembly including a frame bracket 16, a trailing arm 18, a beam extension 19 and an air spring 20. The frame bracket 16 is rigidly secured to the frame 10 by welding and/or bolts in conventional fashion. The trailing arm 18 is pivotably mounted to the frame bracket 16 through a pivot mounting 26 in conventional fashion. A shock absorber 22 is mounted between the frame bracket 16 and the beam 18 to damp the pivotable movement of the beam 18 with respect to the frame 16. The shock absorber 22 is mounted to the frame bracket 16 through a pivot mounting 30 and is pivotably mounted to the beam 18 through a pivot mounting 28. A round axle 24 is secured to the beam 18 through a pair of beam-axle connectors 64 (only one of which is shown in FIG. 1) and a bolt 82.

The suspension system according to the invention includes two trailing arm assemblies, one on each side of the vehicle frame, although only one such assembly is shown in the drawings. The other trailing arm assembly is a mirror image of the described assembly. The trailing arm assemblies are joined by the axle 24.

Referring now to FIGS. 2, 3, 4 and 7, the beam 18 has a top plate 32, a pair of side plates 34 and 36 and a bottom plate 38 all rigidly joined together, for example, by welding to form a rigid elongated beam which is rectangular in cross section. An I

beam can be used in lieu of a box beam. Aligned openings 40 are provided in the side plates 54 and 36. A sleeve 42 is provided at a rear end of the beam and is formed by arcuate plates 44 and 48 which are joined at edge surfaces 46 and 50, respectively. As shown in FIG. 7, a front end of the beam 18 has a cylindrical collar 52 having an opening 54 therethrough to receive the pivot mounting 26.

Referring once again to FIG. 4, a bushing assembly 56 is mounted in the beam openings 40 and comprises an outer sleeve 58, a rubber bushing 60 and an inner sleeve 62, assembled together as a unit. Sleeve 62 and rubber bushing 60 are bonded together and then pressed into sleeve 58. As illustrated in FIG. 4, the outer sleeve 58 and the inner sleeve 62, as well as the bushing 60, are slightly longer than the distance between the outside surfaces of the side plates 34 and 36. The inner sleeve 62 is longer than the outer sleeve 58 and the bushing 60.

Turning now to FIGS. 3 and 7, there are two beam-axle connectors 64 joined to the axle 24 at one end and to the beam 18 at the other end through the bushing assembly 56 on each trailing arm assembly. Each of the beam-axle connectors 64 are identical in construction and are oriented in mirror image orientation on the axles. Only one of the beam-axle connectors 64 will be described.

In FIG. 7, the beam-axle connector 64 comprises a wrapper band 66 at one end formed by an arcuate plate 68 having an edge 70 and an arcuate plate 72 having an edge 74. A triangular plate 76 is welded to the arcuate plate 72 at one side of the arcuate plate adjacent to the beam. A through bore 78 extends through the triangular plate 76 at a forward apex end of the plate 76. Triangular gusset plates 80 are mounted to the top and bottom of the triangular plate 76, preferably by welding, and are secured at the rear end thereof to the arcuate plate 72 along the axial length thereof at upper and lower portions thereof. As illustrated in FIG. 4, a bolt 82 extends through the through bores 78 on each of the beam-axle connectors 64 and through the bushing assembly 56, in particular, through the inner sleeve 62 to mount the beam-axle connector 64 to the beam 18. To this end, a nut 84 is threaded onto the bolt 82. As shown in FIG. 4, wear washers 92 are provided between the triangular plates 76 and the sleeve 62 to provide a wear surface. As also illustrated in FIG. 4, the inner

sleeve 62 extends beyond the axial length of the outer sleeve 58 so that the beam-axle connectors 64 are free to articulate with respect to the beam 18 to accommodate roll and pitch forces at the axle 24 with respect to the frame 10. Washers 93 are mounted on the bolt 82 between the head of the bolt 82 and the triangular plate 76 at one side of the beam and between the nut 84 and the triangular plate 76 at the other side of the beam.

As shown in FIG. 5, the arcuate plates 68 and 72 surround the axle 24 and are joined together through welds 86 at the edges 70 and 74, respectively. The arcuate plates 68 and 72 are squeezed around the axle 24 to maintain the axle in compression and to maintain the arcuate plates 68 and 72 in tension. The arcuate plates are forced toward each other to put the axle 24 in compression before the welding operation. The welds 86 are made while the compressive forces are applied to the axle 24 by the arcuate plates 68 and 72. As the weld joint cools, it contracts, thereby enhancing the compressive forces against the axle 24. The axle 24 is thus joined to the beam-axle connectors 64 through the wrapper bands 66 and are held essentially by friction between the wrapper band 66 and the axle 24 due to the high compressive loading on the axle 24 by the wrapper band 66. The method of assembling the axle to wrapper bands is disclosed and claimed in WO 97/06022, the disclosure of which is incorporated herein by reference. Various embodiments of wrapper bands are disclosed and claimed in this application. Any of the various round axle wrapper band connections disclosed in WO 97/06022 can be used in the invention of the present application. Further, any of the various multi-sided wrapper band connections disclosed in WO 97/06022 can be used with corresponding multi-sided axles in the present invention.

Reference is now made to FIG. 6 for a description of the relationship between the beam and the axle at the trailing end of the beam. The arcuate plates 44 and 48 form a collar which receives the axle 24. An elastomer sheet 88 is positioned between the axle 24 and the arcuate plates 44 and 48. The arcuate plates 44 and 48 are joined by a weld 90 or bolted flanges (not shown). The elastomer sheet 88 can, for example, be made of a urethane or rubber sheet material of approximately 3/16ths inch thick

and about 4 inches wide. The sheet is about as wide at the collar on the beam 18 but slightly shorter in length. Unlike the wrapper band 66, the collar on the beam 18 does not squeeze the axle 24. Rather, the axle can articulate somewhat within the beam collar by virtue of the rubber sheet 88.

Thus, the axle is rigidly connected to the beam-axle connectors 64 through the wrapper bands 66. The beam-axle connectors 64 are rigid in nature and are connected to the beam through the bushing assemblies 56. The rubber bushing 60 is yieldable and thus will deform when torsional stresses are applied to the beam-axle connectors 64. Thus, the axle can articulate with respect to the sleeve 42 of the beam 18 because of the rubber sheet 88 and also in view of the bushed connection 56 between the beam 18 and the axle beam connector 64. Thus, the axle 24 can articulate with respect to the beam 18 but yet is rigidly heid in the beam-axle connectors 64. This suspension avoids stress risers between the axle and the axle bracket, yet the axle can articulate with respect to the beam.

The bushed connection between the beam-axle connectors and the beam also provides for a degree of tolerance in mounting the suspension to the frame. If there is a slight degree of misalignment between the axle and the frame, unreasonable stresses can be set up in a rigid axle connection, resulting in premature axle failure. The bushed connection between the beam and the beam-axle connectors 64 provides a level of tolerance for slight misalignment in mounting of the suspension to the frame and minimizes stresses in the axle due to misalignment of the suspension to the frame.

The invention also provides for economies of scale in manufacturing. The basic beam 18 is symmetrical about a horizontal axis and thus can be used on both sides of the suspension. Thus, there is less tooling and fewer inventory parts. The cost of the beam is thus lower.

The beam can also be used for different suspensions by simply adding on to the basic beam structure for different kinds of beams. These other suspensions are illustrated in FIGS. 8 and 9 to which reference is now made.

FIG. 8 shows a suspension system according to the invention where like numbers have been used to designate like parts. In FIG. 8, a suspension system 12

has a beam 100 of substantially identical construction with the beam 18 except that it accommodates a square axle 104. The axle 104 is joined to the beam through a beam-to-axle connector 106 through a bushed joint 108. The construction of the axle-to-beam connector 106 is essentially the same as the beam-axle connector 64 except that it accommodates a square axle. The beam-axle connector 106 has a wrapper band 107 which squeezes the axle 104 as the wrapper band is assembled onto the axle in a manner described in WO 97/06022. The suspension in FIG. 8 accommodates a rubber spring 102 rather than an air spring as in the previous embodiment.

Turning now to FIG. 9, another embodiment of the invention is shown and like numerals are used to designate like parts. A beam 110 of substantially identical construction with the beam 18 is pivotably mounted to a frame bracket 16 in a pivotable mounting 26. An axle 24 is mounted to a beam-axle connector 64 through a wrapper band 66 in a manner identical to the first embodiment described above. In this embodiment, a beam extension 112 is welded to the outer end of the beam 110 and supports an air spring 20 in a low-slung position for a low mounting height configuration.

Referring now to FIGS. 10 and 11, there is shown an alternate embodiment of the invention where like numerals are used to designate like parts. In this form of the invention, the beam axle connector is modified somewhat and is welded to the axle 24 rather than squeezed onto the axle as in the previous embodiments. More particularly, a modified beam axle connector 122 comprises a triangular plate 129 which has an opening at a forward end thereof and has a bolt 82 extending therethrough for connecting the plate 129 to the trailing arm 18 through a bushed joint identical with that illustrated in FIG. 4 and described above. The triangular plate 129 has an arcuate plate 124 mounted at a rear end thereof, an upper gusset plate 126 mounted to an upper portion thereof and a lower gusset plate 128 mounted a lower portions thereof. As illustrated in FIG. 10, the arcuate plate has a circumferential arc of about 90°. The edges of the arcuate plate 124 are welded to the axle 24 at weld bead 130 at an upper portion thereof and at weld bead 132 at a lower portion thereof. As in the previous

embodiment, a beam axle connector 122 is provided on each side of the beam 18 and each of the beams 18 has two beam axle connectors.

The beam axle connectors illustrated in FIGS. 10 and 11 mount the axle 24 to the beam 18 through a pair of articulated joints, one of which is the bushed joint illustrated in FIG. 4 and the other of which is the connection between the axle 24 and the beam 18 through the sleeve 42 and the elastomeric sheet 88. To this extent, the axle-to-beam connector functions in the same manner in the embodiment shown in FIGS. 10 and 11 as in the embodiments shown in FIGS. 1-9.

The invention provides for articulation between the axles and beams to give flexibility to the beams to accommodate stresses due to roll of the axle. Further, the suspensions avoid the problem of tolerances and stresses of mounting brackets resulting from misalignment of the suspensions to the frame. Still further, the lateral motion of the axle with respect to the frame is accommodated in the suspension as a couple due to the two beam-to-axle suspension mountings. The couple will react to lateral motion and avoid the necessity of a track bar between the axle and the beam.

Reasonable variation and modification are possible within the scope of the foregoing disclosure and drawings without departing from the spirit of the invention.

CLAIMS

The embodiments for which an exclusive property or privilege is claimed are defined as follows:

1. In a vehicle suspension for mounting ground-engaging wheels to a vehicle frame, the suspension comprising at least two arms adapted to be secured to opposite sides of the frame; at least one wheel-carrying axle mounted to the arms through an axle-mounting assembly, characterized in that:

each of the axle-mounting assemblies comprises at least one beam-axle connector which is mounted to one of the arms at one end thereof through a bushed connection and is connected to the axle at another end thereof; and

each of the arms forms a collar which receives the axle;

and an elastomeric layer between the axle and the collar for articulation between the axle and the collar.

2. A vehicle suspension according to claim 1 wherein the beam-axle connector is rigidly mounted to the axle at the other end thereof.

3. A vehicle suspension according to either of claims 1 or 2 wherein there are two beam-axle connectors, one on each side of each arm, and each beam-axle connector is connected to the arm and to the axle in the same manner.

4. A vehicle suspension according to claim 3 wherein each of the beam-axle connectors is identical and is symmetrical about a longitudinal axis.

5. A vehicle suspension according to any of claims 1-4 wherein each beam-axle connector is generally triangular in two dimensional configuration and has a reinforcing gusset at an upper portion thereof and at a lower portion thereof.

6. A vehicle suspension according to any of claims 1-5 wherein each beam-axle connector further includes an arcuate plate at the other end thereof and through which the beam-axle connector is mounted to the axle.

7. A vehicle suspension according to any one of claims 1-6 wherein the beam-axle connector is mounted to the axle through a hollow wrapper band which circumscribes the axle and is under tension sufficient to compress the axle at at least two sets of diametrically opposed and circumferentially spaced external surfaces of the axle and to prevent movement of the axle with respect to the wrapper band under ordinary service conditions.

8. A vehicle suspension according to claim 6 wherein the arcuate plate extends about 180° around the axle and mates with a second arcuate plate to form a hollow wrapper band which circumscribes the axle and is under tension sufficient to compress the axle at at least two sets of diametrically opposed and circumferentially spaced external surfaces of the axle and to prevent movement of the axle with respect to the wrapper band under ordinary service conditions.

9. A vehicle suspension according to any of claims 1-6 wherein the beam-axle connector is welded to the axle.

10. In a vehicle having a suspension for mounting ground-engaging wheels to a vehicle frame, the suspension comprising at least two arms secured to opposite sides of the frame; at least one wheel-carrying axle mounted to the arms through an axle-mounting assembly, characterized in that:

each of the axle-mounting assemblies comprises at least one beam-axle connector which is mounted to one of the arms at one end thereof through a bushed connection and is connected to the axle at another end thereof; and

each of the arms forms a collar at a trailing end thereof and the axle is received in the collar;

and an elastomeric layer between the axle and the collar for articulation between the axle and the collar.

11. A vehicle according to claim 10 wherein the beam-axle connector is rigidly mounted to the axle at the other end thereof.

12. A vehicle according to either of claims 10 or 11 wherein there are two beam-axle connectors, one on each side of each arm, and each beam-axle connector is connected to the arm and to the axle in the same manner.

13. A vehicle according to claim 12 wherein each of the beam-axle connectors is identical and is symmetrical about a longitudinal axis.

14. A vehicle according to any of claims 10-13 wherein each beam-axle connector is generally triangular in two dimensional configuration and has a reinforcing gusset at an upper portion and a lower portion thereof.

15. A vehicle according to any of claims 10-14 wherein each beam-axle connector further includes an arcuate plate at the other end thereof and through which the beam-axle connector is mounted to the axle.

16. A vehicle according to any one of claims 10-15 wherein the beam-axle connector is mounted to the axle through a hollow wrapper band which circumscribes the axle and is under tension sufficient to compress the axle at at least two sets of diametrically opposed and circumferentially spaced external surfaces of the axle and to prevent movement of the axle with respect to the wrapper band under ordinary service conditions.

17. A vehicle according to claim 15 wherein the arcuate plate extends about 180° around the axle and mates with a second arcuate plate to form a hollow wrapper band which circumscribes the axle and is under tension to compress the axle at at least two sets of diametrically opposed and circumferentially spaced surfaces of the axle and to prevent movement of the axle with respect to the wrapper band under ordinary service conditions.

18. A vehicle according to any of claims 10-15 wherein the beam-axle connector is welded to the axle.

19. The invention defined in any of the preceding claims wherein the axle is substantially round in cross section.

20. The invention defined in any of the preceding claims wherein the axle is polygonal in cross section.

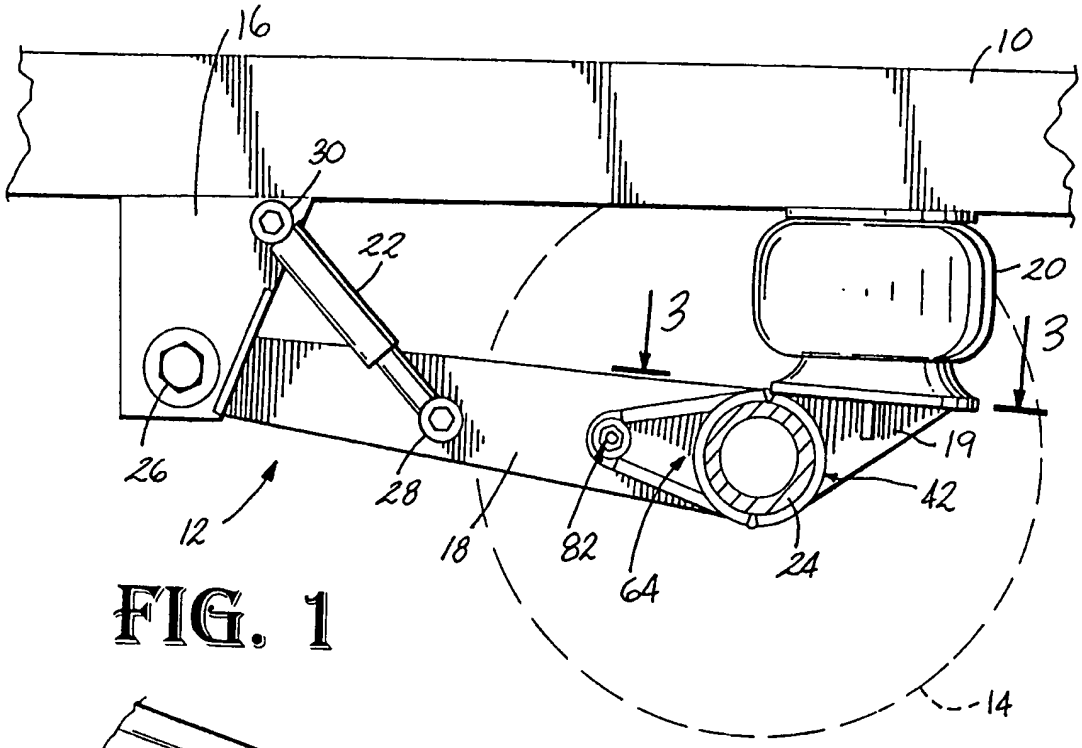
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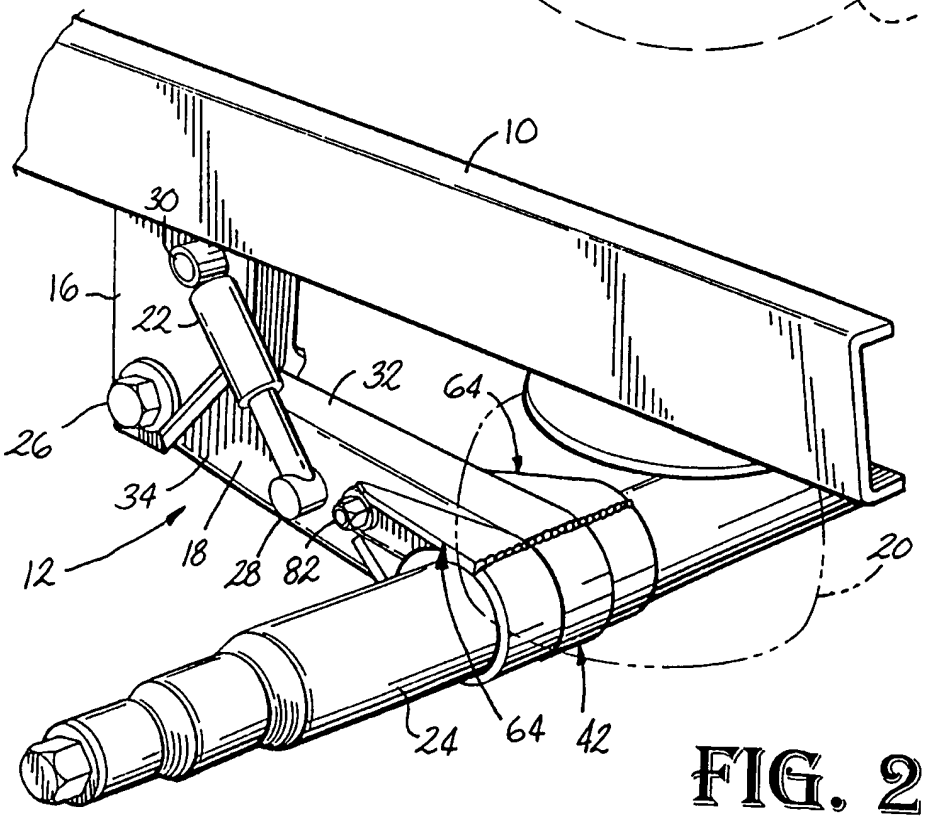
FIG. 1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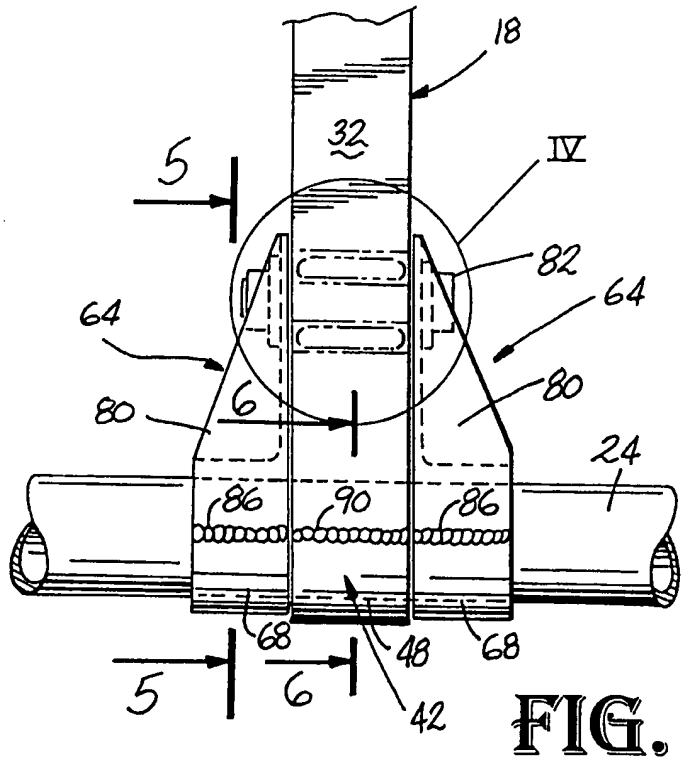
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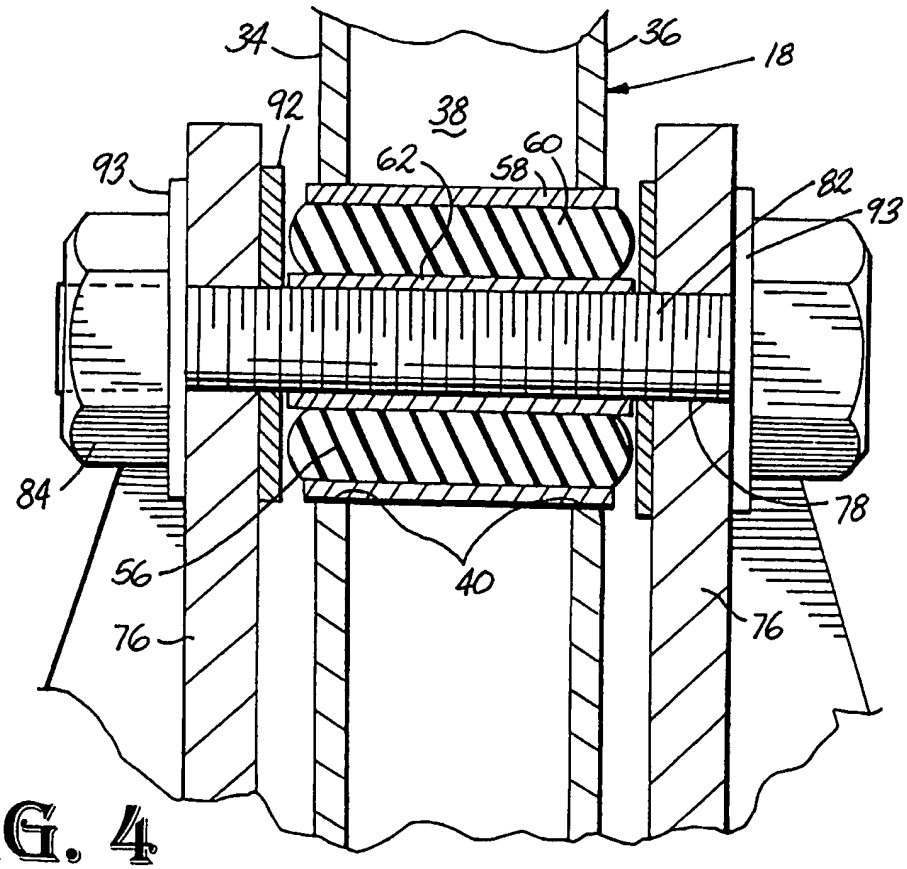
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FIG. 4

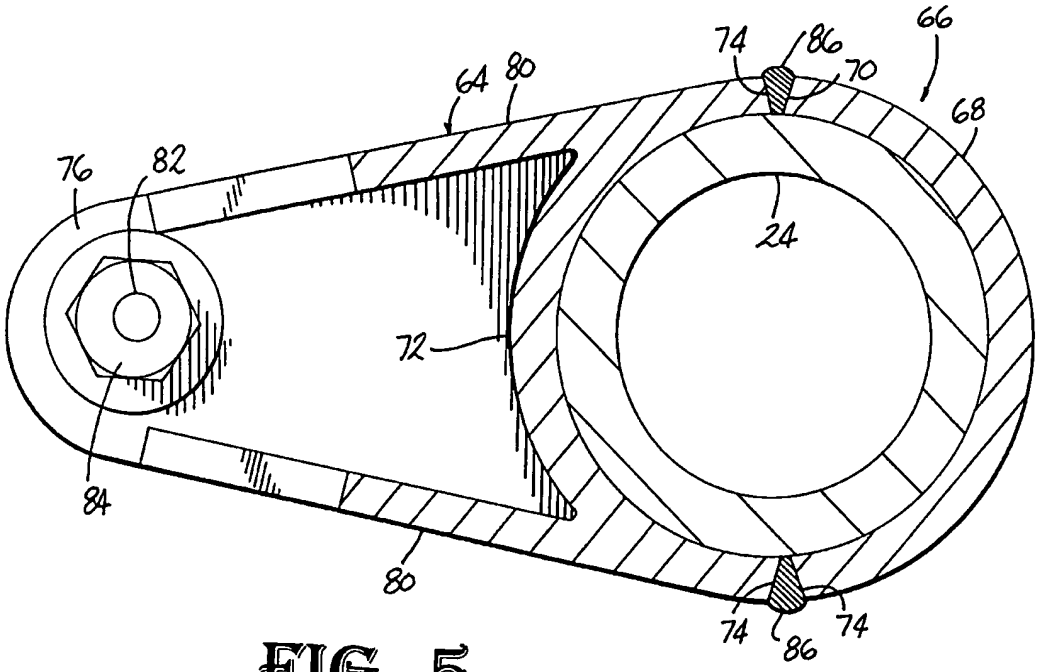
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FIG. 5

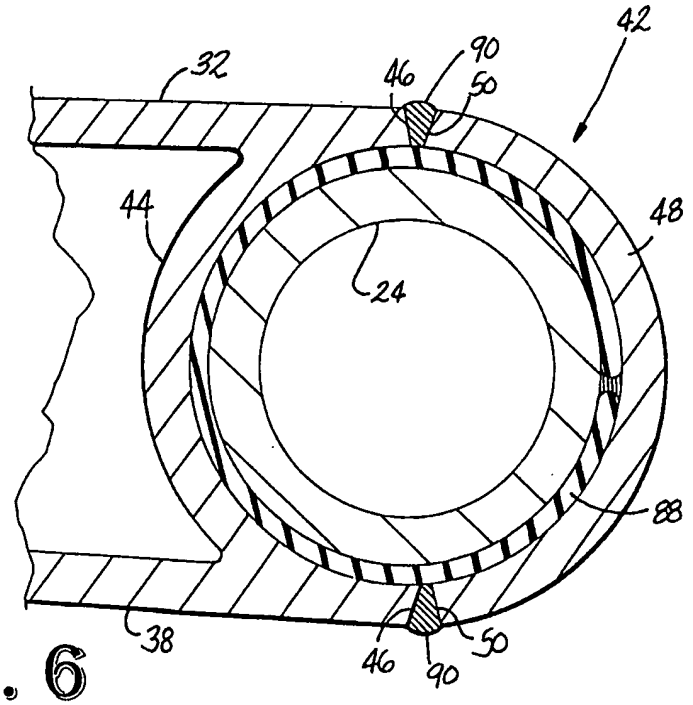
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FIG. 6

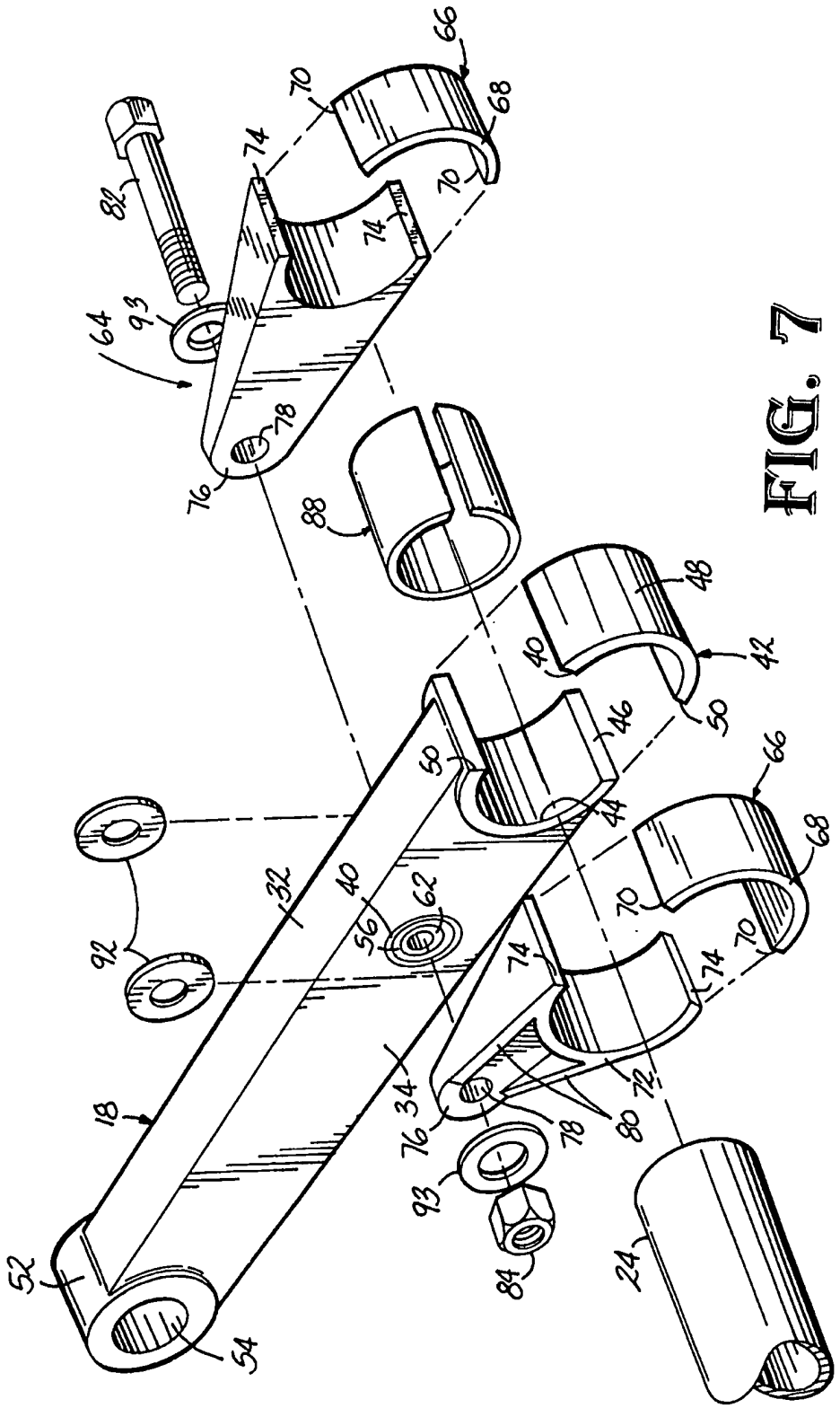
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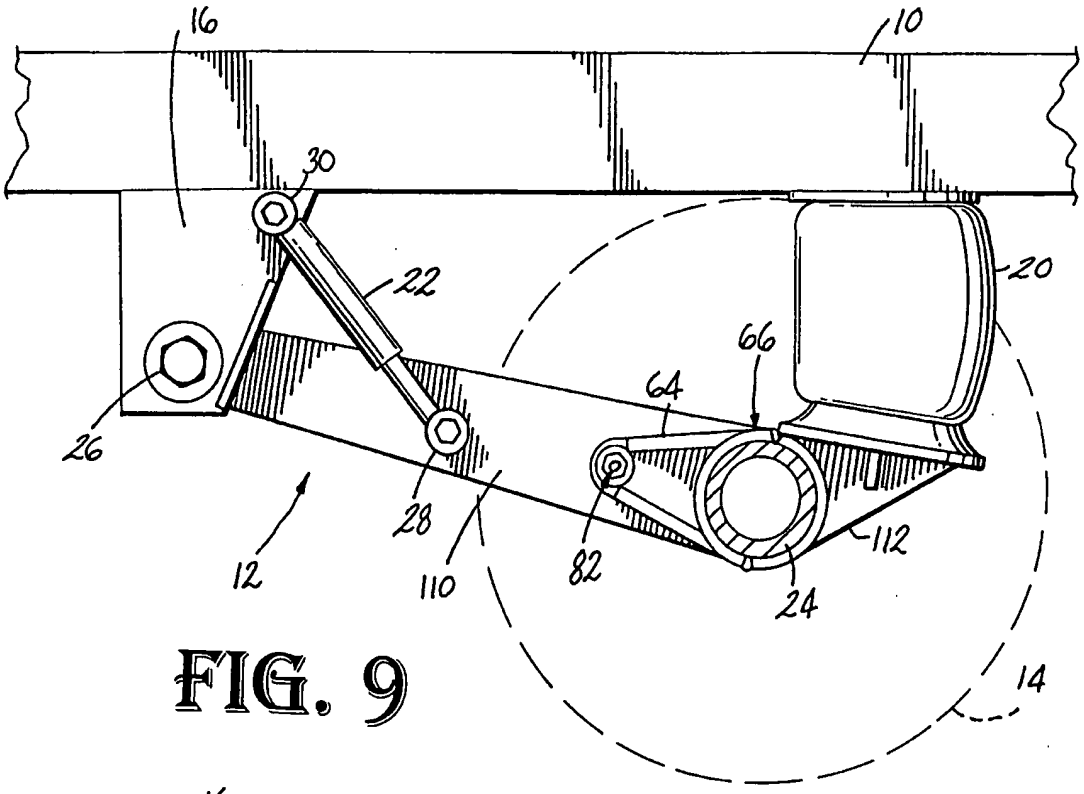
FIG. 7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22
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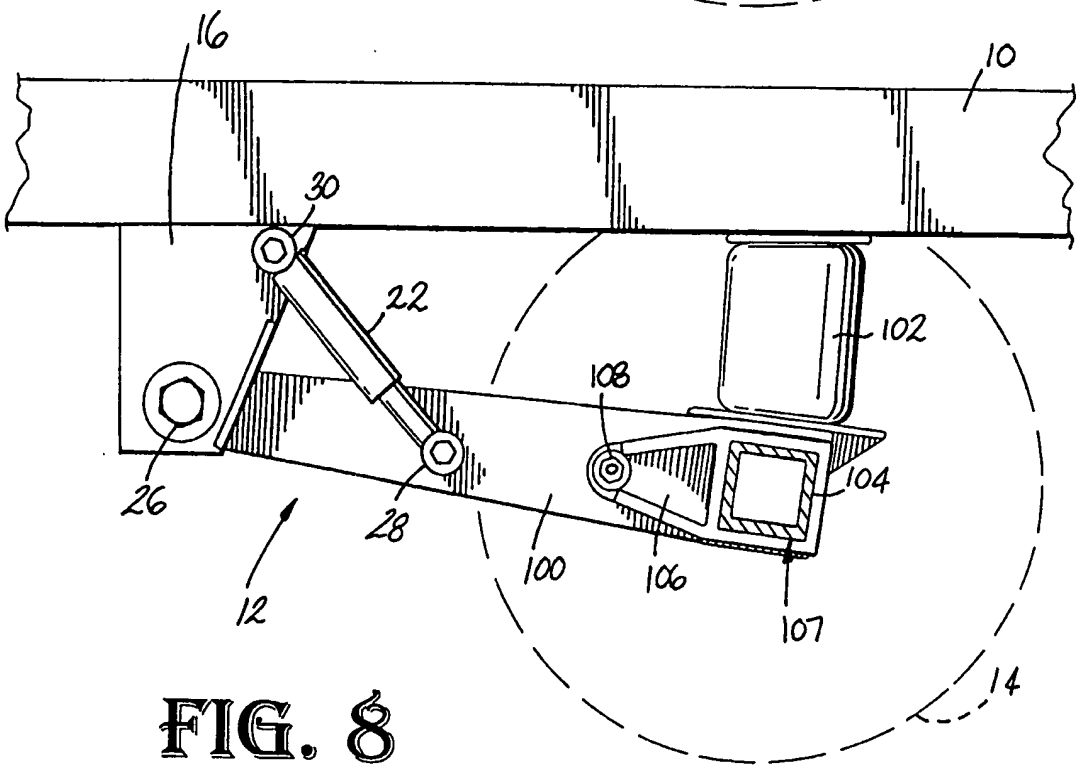
66
64
26
28
12
110
82
112
24
14

FIG. 9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102
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107
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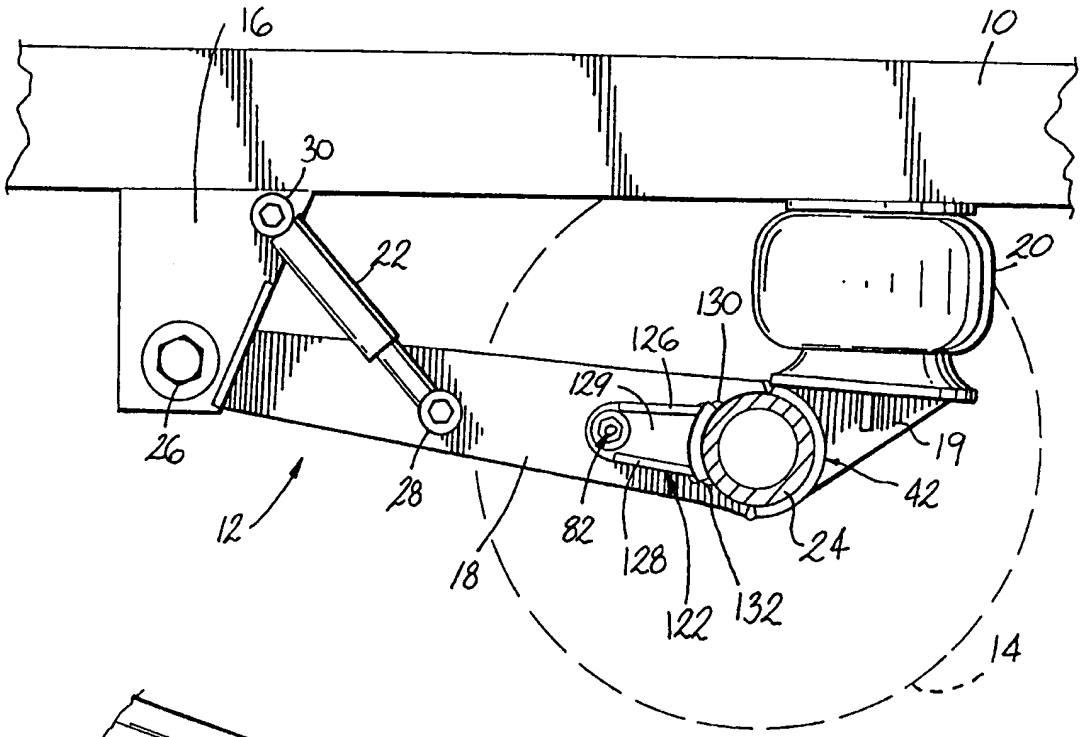
FIG. 8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130
126
129
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128
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122
132
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FIG. 10

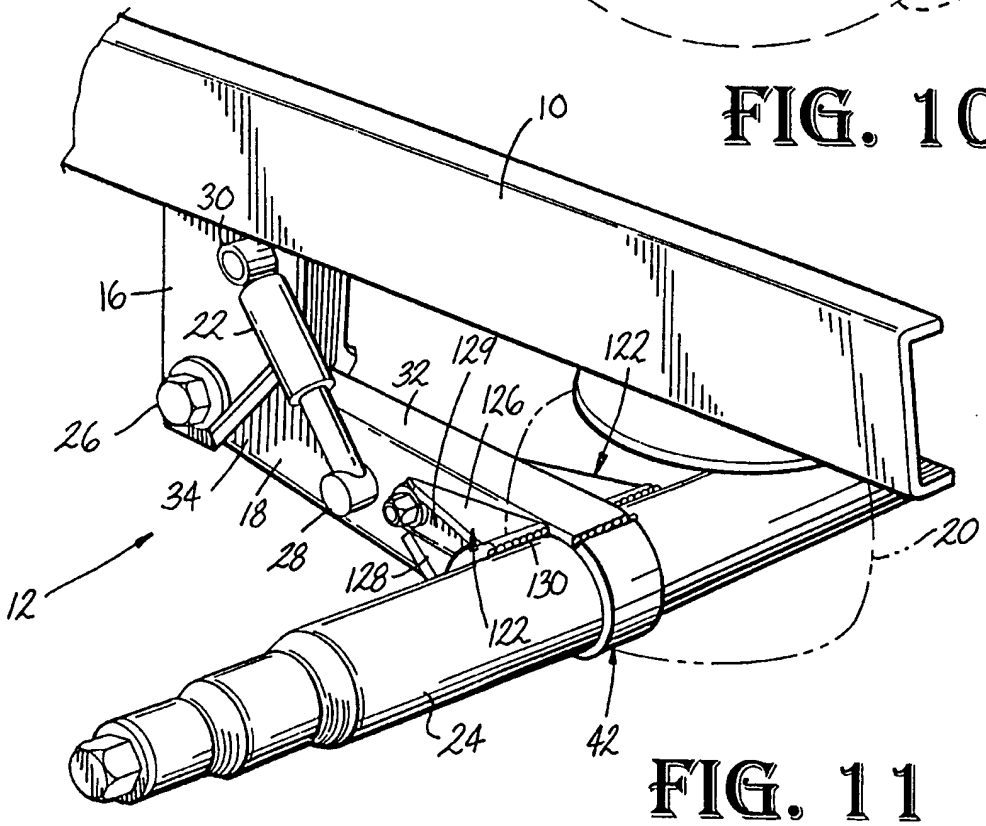
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FIG. 11

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/18733

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B60G9/00 B60B35/04

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B60G B60B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 12 65 596 B (ADAM OPEL) 4 April 1968 see column 4, line 61 - column 6, line 35; figure 1	1-5, 9-14,18, 19
A	US 2 865 652 A (EASTON, F.B.) 23 December 1958 see the whole document	1,10
A	US 2 367 817 A (BROWN, R.W.) 23 January 1945 see figures 3-6,8	
A	US 4 293 145 A (TAYLOR GLENN E) 6 October 1981 see figures	

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 February 1998	12/02/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Tsitsilonis, L

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 497 504 A (DUFF, J.M.) 5 February 1985 see figures	
A	EP 0 600 198 A (BOLER CO) 8 June 1994 see figures 11-15	
A	US 4 310 171 A (MERKLE, R.H.) 12 January 1982 see figures	
A	DE 77 28 344 U (BERGISCHE ACHSENFABRIK FR. KOTZ & SÖHNE) 24 May 1978 see figures	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 97/18733

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